Facial Soft Tissue Measurement in Microgravity-induced Fluid Shifts

Thomas Marshburn, Richard Cole, James Pavela , Kathleen Garcia, Ashot Sargsyan

Introduction: Fluid shifts are a well-known phenomenon in microgravity, and one result is facial edema. Objective measurement of tissue thickness in a standardized location could provide a correlate with the severity of the fluid shift. Previous studies of forehead tissue thickness (TT_f) suggest that when exposed to environments that cause fluid shifts, including hypergravity, head-down tilt, and high-altitude/low-pressure, TT_f changes in a consistent and measurable fashion. However, the technique in past studies is not well described or standardized. The International Space Station (ISS) houses an ultrasound (US) system capable of accurate sub-millimeter measurements of TT_f. We undertook to measure TT_f during long-duration space flight using a new accurate, repeatable and transferable technique.

Methods: In-flight and post-flight B-mode ultrasound images of a single astronaut's facial soft tissues were obtained using a Vivid-q US system with a 12L-RS high-frequency linear array probe (General Electric, USA). Strictly mid-sagittal images were obtained involving the lower frontal bone, the nasofrontal angle, and the osseo-cartilaginous junction below. Single images were chosen for comparison that contained identical views of the bony landmarks and identical acoustical interface between the probe and skin. Using Gingko CADx DICOM viewing software, soft tissue thickness was measured at a right angle to the most prominent point of the inferior frontal bone to the epidermis. Four independent thickness measurements were made.

Results

Image	Measurements (mm)	Average (mm)	% Change
In-flight	5.2; 5.25; 5.43; 5.21	5.27±.05	
Post-flight	4.82; 4.58; 4.82; 4.76	4.745±.06	-9%

Conclusions: Forehead tissue thickness measurement by ultrasound in microgravity is feasible, and our data suggest a decrease in tissue thickness upon return from microgravity environment, which is likely related to the cessation of fluid shifts. Further study is warranted to standardize the technique with regard to the individual variability of the local anatomy in this area.